Technical Notes for Operating a Fermilab PIP-II Downconverter at 1408 MHz

Ed Cullerton 4/20/2020

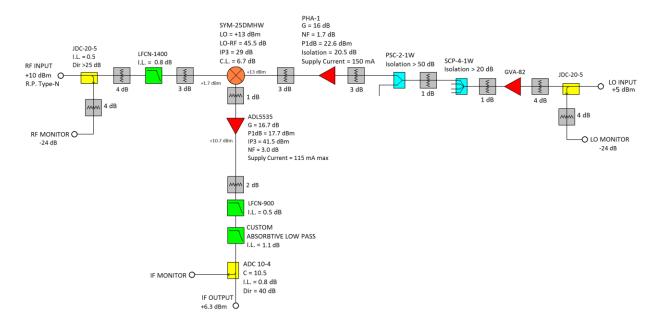
The Fermilab PIP-II downconverter was designed for operation using RF frequencies of 162.5 MHz to 650 MHz, and an IF frequency of 20 MHz. To explore if this downconverter can work at an RF frequency of 1408 MHz, this note documents some experimental data done at 1300 MHz for the prototype (Rev. A) of this downconverter. This data is followed by some suggested modifications to the board using drop-in replacement parts so this board may operate at an RF frequency of 1408 MHz.

Experimental Data at 1300 MHz:

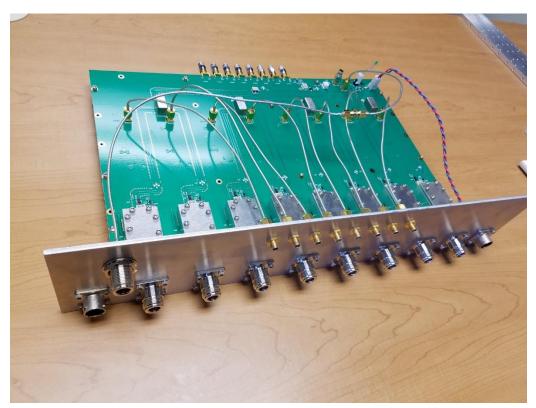
A prototype (Rev A) of this board was produced in Nov 2016, and the board was measured at 162.5, 325, 650, and 1300 MHz. Below is the relevant measured data at 1300 MHz. Please refer to production Rev B datasheets for data at other frequencies.

** Data for the IF output spectrum and temperature stability is not included.

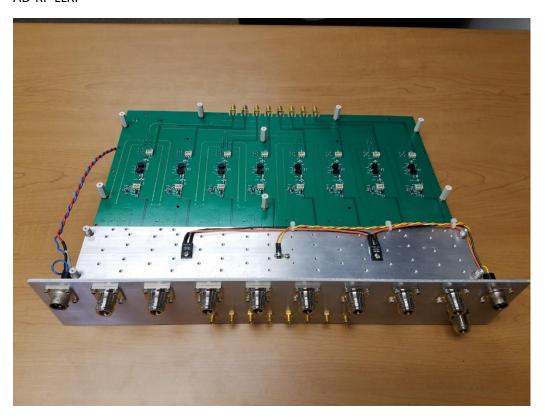
Block diagram:



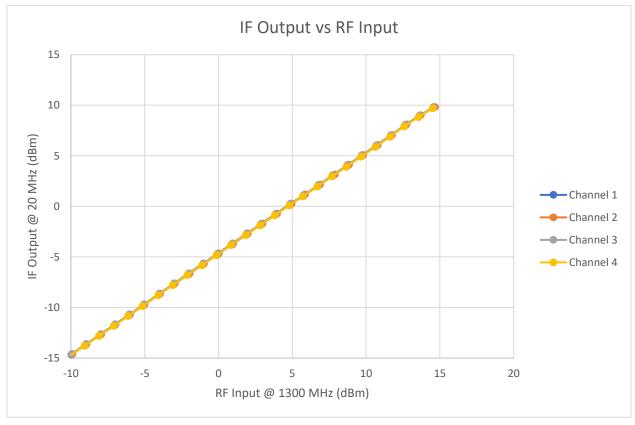
Test fixture pictures:



Fermi National Accelerator Laboratory AD-RF-LLRF



RF to IF Conversion data (only channels 1-4 measured):

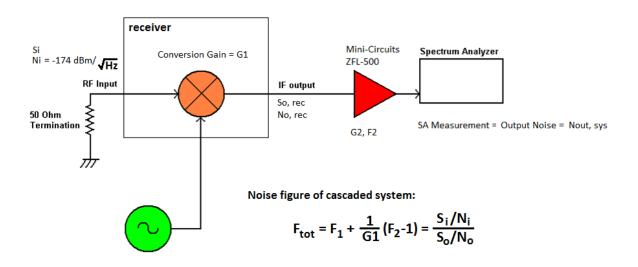




Channel to Channel Isolation:

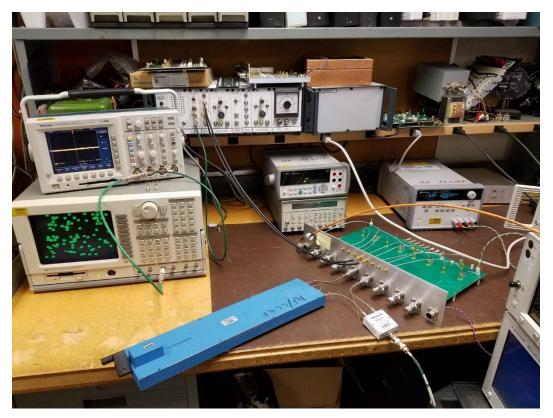
	1	2	3	4	5	6	7	8
1		-84.8	-92.5	-101	-99.2	-110	-110.1	-105.5
2	-94.9		-84	-97.7	-99.9	-99.5	-93.8	-92.5
3	-95.6	-84.7		-85.1	-87.9	-100.4	-98.6	-93.4
4	-98	-97.7	-94.5		-82.3	-93	-105	-88.8
5	-106	-107	-97.7	-90		-86.8	-87.1	-89
6	-115	-99.7	-101	-89.8	-111		-77.5	-82.7
7	-116	-102	-97.7	-100	-91.8	-85.1		-75
8	-113	-104	-100	-105	-94	-92.6	-85.3	

Noise Figure Measurement:



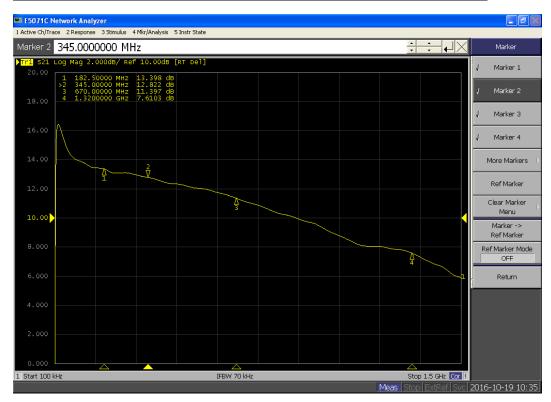
1300 MHz		
G1	-4.7	0.338844156
F2	5.6	3.630780548
G2	24.2	263.0267992
Ni	-174	3.98107E-18
No	-131	7.94328E-14
No/Ni	43	19952.62315
So/Si	19.5	89.12509381
Ftot	23.5	223.8721139
F1	23.34671105	216.10813
No, rec	-155.353289	2.91522E-16
FS output	5.3	
Nout, dBc	-160.653289	

1/f Noise Measurement

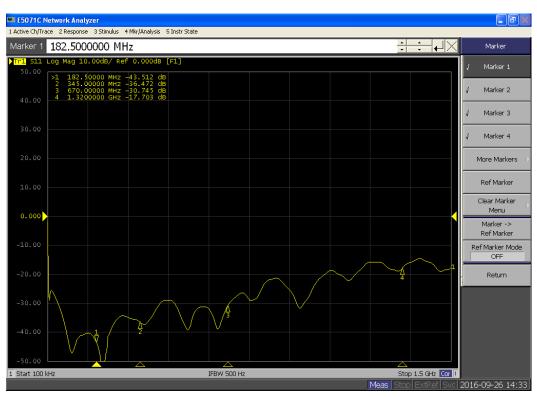


rrequent Covert to		racion=				1.30E+09 2.45E-01	e-
Convert to radians: sqrt(2 * 10^([dBc meas]/10)) = Frequency of calculation =						2E-06	гао
	4:-		001140	1/201		05.00	
Integrate	Noise fro	om 0.02 to	10^(mea	 s/10) * In:	 (20/0.02) =	-116.976	dBc
1 Hz		-125.369	Assumin	g 10 dB/d	ecade of 1	L/f noise :	slope
Offset add		-138.369	= Measurement - (Volts/rad) - 60 - 3				
20*log(V/rad) Measurement @ 2		-81					
		-5.63099					
Volts/rad		0.52294					
Counts/Volt		840					
Counts/200mV		168					
Counts @ 200 mV		4229					
Counts/rad		439.268					
Counts/180 deg		1380					
Count at:	180 deg	5441					
Starting	ounts	4061					
		(1.3GHz)					

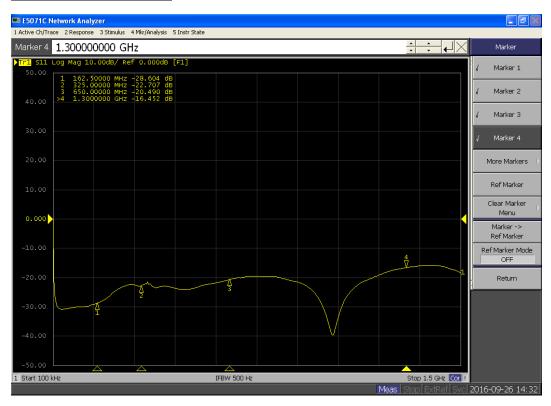
LO requirements- S21 from LO Input to 3 dB Pad Before Mixer:



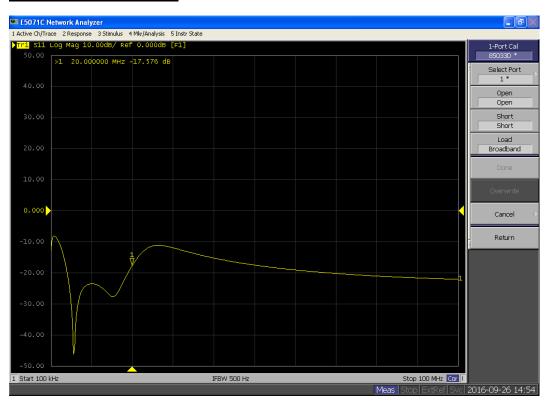
LO Input Return Loss:



RF Input Return Loss:



IF Output Return Loss:



Proposed changes for operation at 1408 MHz:

A few parts on the board are not rated for operation at 1408 MHz, but they may be replaced with drop in components that do. Below is the modified block diagram with the proposed changes:

